North Cascades National Park
Ross Lake and Lake Chelan National Recreation Areas
Sedro Woolley, Washington 98284

LAKE CHELAN

FISH FAUNA AND LIMNOLOGY STUDIES

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LAKE CHELAN
FISH FAUNA AND LIMNOLOGY STUDIES

Introduction

Studies at the head of Lake Chelan, Washington were conducted by park research biologist Robert Wasem and biological technician Kevin Mullen on 16-19 June 1975. Several streams tributary to Lake Chelan also were studied in November 1975. Prior research at the head of Lake Chelan was carried out in June 1972 (Wasem 1972), June 1973 (Wasem 1974a), and in June 1974 (Wasem 1974b).

Weather conditions during much of the study period were variable with intermittent light winds, partial overcast, and cool air temperatures. However, the lake was calm enough to permit productive work with a minimum of discomfort.

Lake Chelan Limnology Studies - June 1975

Physical and chemical conditions of the lake were measured at the surface (0.25 m depth) at all five mid-lake stations and at the 50 meter (m) depth at stations 2, 3 and 4. Water temperature profiles were made to 90 m depths at stations 2, 3, 4 and 5, and to the bottom (3.75 m) at station 1 (in shallow water near the Stehekin River inlet). Water temperature was measured at 0.5 m intervals to 25 meters and at 1.0 m intervals from 25 meters to 90 meters. A marine hydrographic thermometer with a 90 m calibrated line probe was used to measure water temperature while a one litre capacity Van Dorn type subsurface sampler was utilized to collect water samples at 50 m depths.

Water temperature data are presented in table 1 and figure 1. A two meter thick thermocline existed at station 1 as the colder waters of the inflowing Stehekin River law below the sun-warmed surface layer. There was a near thermocline at station 3 in the sun-warmed surface to the one meter depth. For all intensive purposes the water was virtually homothermous at all stations. For instance, the temperature changed by 2 C between the surface and the 90 m depth at station 2, and only 2.8 C through the 90 m water column at station 5 off Riddle Creek.

Mean temperatures for each water column indicate that the water of Lake Chelan gradually warms the further the distance south from the Stehekin River which is the main source of lake inflow. Smaller lake feeder streams (Castle, Riddle, Canyon, Hazard, Four Mile, etc.) might effect to slow this warming trend by supplying relatively smaller volumes of cold inflow at numerous points along the lakeshore. Table 1 shows that the mean temperature of each water column increased about 0.1 C at each station moving down lake from north to south. Water temperatures at the foot of the lake would be considerably higher than at the head if this warming trend continued the full 88 km length of Lake Chelan.

Lakewater was very clear in all areas except at station 1 where inflowing Stehekin River water created slightly turbid conditions. The Secchi disc visibility increased from 3.2 m at station 1 to 13.0 m at station 5 with turbidity readings decreasing accordingly as shown in Table 2.

Table 2 also gives other aspects of water quality at each station. Dissolved oxygen was at saturation or near saturation levels at all stations at both the surface and 50 m depths. Results for HCO_3 alkalinity, pH, specific conductance and hardness were not significantly different at either the surface or 50 m depths at stations 2, 3, 4 and 5. However, much lower levels of all these constituents were found at station 1 which was influenced by the more-sterile snowmelt water carried into Lake Chelan by the Stehekin River and several nearby smaller streams.

Water at the head of the lake can be classified as being on the borderline between very oligotrophic (very soft) and oligotrophic (soft) as based upon a classification system suggested by Lennon (1959).

In 1975, for the first time, several forms of nitrogen were measured near the surface at each of the five stations. Tests were made using Hach Chemical Company (1971) reagents and procedures with a Bausch and Lomb Spectronic 20 spectrophotometer. Results are give in Table 3. Ammonia (NH_3) ranged between 0.36 and 0.43 mg/l, while ammonium (NH_4^+) varied from 0.39 to 0.45 mg/l. Total nitrate + nitrite was fairly constant between 0.172 and 0.176 mg/l. Nitrate (NO_3^-) ranged between 0.158 and 0.172 mg/l while all readings for nitrite (NO_2^-) were less than 0.01 mg/l.

Zooplankton Sampling

Zooplankton biomass was determined by near-surface horizontal net tows and vertical net hauls (30 m to surface) at Stations 2 and 4 on the morning of 19 June. A Birge closing plankton net with a 13 cm mouth diameter and 80 micron mesh size was used with a calibrated nylon tow line.

Weather conditions were ideal - no wind, sunny, and warm. Vertical hauls at Station 2 were made between 1056 and 1115 PDT, and the horizontal tow was made between 1118 and 1123 PDT. At Station 4 the vertical hauls were made between 0932 and 1010 PDT, and the horizontal tow was made between 1032 and 1037 PDT.

Zooplankton samples were washed from the plankton bucket into preservation jars containing five percent Formalin as a preservative. A small wash bottle filled with distilled water was used to rinse all traces of plankton from the bucket. The samples were later filtered through pre-weighed filter paper and allowed to air dry for several days before a final weighing. Plankton biomass was calculated as the weight gain of the filter paper. Results are presented in tables 4 and 5.

Biomass per unit volume of water could not be calculated for the horizontal tows because of the lack of a metering device to measure distance the net traveled or the volume of water passing through the net. Horizontal tow efforts were standardized by towing the net for five minutes at a 500 rpm engine speed. The tow at Station 2 produced 0.26 grams as compared with 0.18 grams at Station 4.

Ten vertical 10 to 30 meter hauls produced between 0.158 grams and 0.395 grams per cubic meter (g/m^3) of water with a mean 0.237 g/m^3. The mean zooplankton biomass for the five hauls at Station 2 was 0.228 g/m^3 with extremes of 0.395 and 0.158 g/m^3. At Station 4 the mean was 0.246 g/m^3 with extremes of 0.316 and 0.210 g/m^3.

Previous plankton collections were made on 12 and 13 August 1969 by students of the Skagit Valley Community College Oceanographic Summer Institute (Anon. 1970). These were made in the vicinity of Twenty-five Mile Creek and off the Lake Chelan State Park. In this study 15 meter vertical hauls produced 0.56 g of plankton at 1800 hours on 8/12; 0.58 g at 2400 hours; 0.29 g at 0600 hours on 8/13; and 0.35 g at 1200 hours on 8/13.

Fish Fauna Studies

For the fourth year species distribution and relative abundance was investigated by the use of experimental (variable mesh) gill nets of monofilament construction. Nets worked off the bottom and were attached to shore. All sets were made along the northeast shoreline south of Purple Point. Four sizes of nets were used in six sets in 1975: 36.6 m x 1.8 m, 45.7 m x 1.8 m, and 13.7 m x 1.5 m. The smallest net has a very fine mesh of less than 1.27 cm bar dimension.

The six net sets worked a combined total of 127 hours to capture but 36 fish of six species. In June 1974, four overnight sets captured 64 fish of seven species while working a total of 70.4 hours (Wasem 1974b).

The 1975 mean capture rate of 0.283 fish per hour of gill net set and 0.087 fish per 100 m^2 gill net per hour was far less than respective rates of 0.91 and 0.34 of June 1974. The two small fine-mesh sets fishing in shallow bays caught no fish, therefore increasing the wide difference in catch rates between the two years. Table 9 summarizes comparable fish capture efforts and results from 1972 to 1975.

Table 6 lists the six species captured in 1975. Four species of non-sport fish comprised 91.7 percent of the catch. Tables 7 and 8 summarize lengths, weights and condition factors. The largest fish taken was a gravid female squawfish with a 521 m (20.5 in) fork length and weighing 2,090 g (4.6 lbs).

As with past investigations Dolly Varden charr (Salvelinus malma), cutthroat trout (Salmo clarki), and mountain whitefish (Prosopium williamsoni) were not captured. Dolly Varden and cutthroat are known to be native to the Lake Chelan - Stehekin River ecosystem but may now be almost entirely absent from the lake itself. The mountain whitefish probably was never native to the system as evidenced by failure to capture a single specimen in four years of netting. Kokanee salmon (Oncorhynchus nerka), a dwarfed form of the anadromous sockeye salmon, was introduced to the lake in 1917 along with rainbow trout. Failure to consistently capture kokanee by conventional gill net is not uncommon as this species generally inhabits open water well out of the reach of shallow shoreline sets.

Table 10 summarizes all fish species caught by year since June 1972. The non-sport fishes comprised of peamouth, northern squawfish, largescale sucker and longnose sucker as a group comprised 238 of the 257 total fish or 92.6 percent. These results suggest that native non-sport fishes are doing very well in Lake Chelan while native sport fishes (Dolly Varden charr, cutthroat trout) may be virtually extinct having been replaced by introduced rainbow trout and kokanee salmon. The Washington State Department of Fisheries is presently attempting to establish a chinook salmon (Oncorhynchus tshawytscha) sport fishery in the lake. This program began in June 1974. Present status of this program is not known, at least to this author.

Stream Surveys

Basic water quality was measured on 16 streams of the Stehekin River - Lake Chelan drainage in 1975. Measurements were made as time permitted in conjunction with other field work in the area. These data are presented in table 11. Generally streams were clear, cold, and low in cation and anion constituents as would be expected from headwater streams of the Northern Cascades. These data indicate the water quality was excellent and fully meeting State water quality standards for Class AA (Extraordinary) waters.

In comparing chemical water quality of the various streams, one interesting phenomenon was discovered. The three major streams draining the extreme southeast corner of the Lake Chelan National Recreation Area (Flick Cr., Fourmile Cr., Hazard Cr.) are considerably more productive than other streams of the area. For instance, these three streams averaged 86 Mhos/cm in specific conductance in November (68 to 103 extremes), while the other eight streams measured in November averaged but 41 Mhos/cm (24 to 58 extremes). This amounts to a 110 percent increase. Other water quality constituents (pH, HCO_3, hardness, TDIS) are equally higher as would be expected. Reasons for this difference are unknown as the bedrock geology is virtually the same for the entire drainage. Similar situations have been discovered in other areas of the North Cascades (Copper Cr. - Alma Cr. and Hozomeen Cr. - Hozomeen Lake - Willow Lake areas).

In early November 1975, twelve streams were briefly surveyed to determine their suitability for spawning by kokanee salmon. Three of the larger streams plus Company Creek (the single most important kokanee spawning area) were measured for widths, depths, water velocity, and volume discharge. Measurements were made at one station near the points where these streams discharge into other water bodies.

Stream widths were measured with a calibrated nylon line while depths were determined by measuring to the closest centimeter at 0.25 m or 0.5 m intervals across the channel. Stream velocities were determined by use of a Model 2030 digital flowmeter made by General Oceanics, Inc. The flowmeter was held in mid-channel at mid-water depths. Five trials were made with the mean of the five results calculated as the mean velocity. Stream width, depth and flow data is presented in table 12. Purple Creek and several other smaller streams were dry at their lake confluences though exhibiting surface flow at higher elevations with bedrock substrate.

With the exception of Devoire Creek all streams entering Lake Chelan within the recreation area were briefly surveyed on 4 and 5 November for existing Kokanee salmon spawning activity and potential value as salmon spawning streams. Survey results are given for each stream as follows:

Bridal Veil Creek 11/4/75

Stream drops over a significant waterfall into the lake. No spawning potential unless in the waterfall pool or in the lake just off the waterfall. The waterfall forms a natural upstream migration block to kokanee and trout.

Canyon Creek 11/4/75

No salmon were observed in the stream or lake. With the lake lowered to the 364 m elevation, a steep rock-cobble stream about 11 m long is exposed with a few small gravel deposits available for spawning. However, the water velocity is too high and no quiet pools are available to attract potential kokanee spawners.

Castle Creek 11/4/75

Flows over a steep rocky alluvial fan where it breaks into several channels of which most were dry. Also several channels are blocked by low (1 m high) log barriers at the normal full-pool lake level (335 m). Generally the stream is too steep and rapid and with no pools to permit salmon spawning. No kokanee were observed in the stream or in the lake just off the stream.

Flick Creek 11/5/75

A very small stream during the autumn months. Stream not of sufficient size or gradient or with suitable gravel deposits to permit salmon spawning. No kokanee

were seen in the stream or in the lake off the stream outlet.

Fourmile Creek 11/5/75

Flows across an alluvial fan composed of small rock and cobbles where it splits into two small channels before emptying into the lake. A 1.5 m high falls at the lake outlet would probably prevent kokanee from gaining access to the stream. Stream bed composed of rock and cobble of little value for fish spawning. No fish were seen in the area except a dead kokanee salmon (spawned-out male, 214 mm FL) in the lake just off the stream mouth.

Hazard Creek 11/5/75

This stream is small and steep with little if any spawning gravel. A 2 m high falls at the lake would prevent kokanee from entering the stream. No fish were observed in the stream or lake off the stream outlet. Believed to have no value for spawning kokanee.

Onemile Creek 11/4/75

This stream was not flowing at the lakeshore but showed some surface flow higher on the mountain. Surface flow sinks into the alluvium and reaches the lake as under water seep. No kokanee were seen in the lake in this vicinity. The stream is of no importance for kokanee spawning.

Riddle Creek 11/4/75

With lake level down (334 m) as is normal this time of year about 55 m of stream is exposed as it flows across a rock-cobble alluvial fan. Some sand and gravel patches exist in this stream stretch but no kokanee were observed. No migration blocks exist to prevent fish from utilizing this short stream section. Above the normal high pool lake elevation the stream steepens considerably and the streambed is mostly rock and boulder and not suited for fish spawning.

Unnamed Streams

Stream just north of Canyon Creek drops over rock cliff into lake. No salmon seen in lake. No spawning value unless fish use a 10 m stretch of gravel between the base of the falls and the lowered lake.

Stream just north of Onemile Creek and south of Painted Rocks not shown on topographic map. Stream drops over 3 m high falls into lake. No fish seen in area. Falls would preclude value of stream for kokanee spawning.

Stream between Castle Creek and Canyon Creek not appearing on the topographic map. Stream drops into lake over a rock cliff. No kokanee seen and has no value for fish spawning.

Generally all streams surveyed were unsuited for kokanee spawning because of one or a combination of the following factors:

1. Stream not flowing at lakeshore.
2. Stream blocked at mouth by a low barrier (log or steep gravel bar) or by a relatively high waterfall over a rock cliff.
3. Stream too small and too steep above normal full-pool lakeshore elevation.
4. Waterflow too rapid with few if any pools and other quiet water sections.
5. Stream substrates mostly of small rocks and cobbles. There is a distinct lack of spawning-sized gravel.

Kokanee salmon might be spawning in spring seep areas of the lake bottom off mouths of tributary streams. Kokanee commonly spawn in gravel deposits of lakebeds of many western lakes. However, salmon activity was not observed at the lake surface. No attempt was made to observe possible underwater spawning activity with a fish scope or other similar device.

Sanitary Water Quality

Bacteriological water quality of non-potable lake and stream water adjacent to public-use areas was tested by membrane filtration by laboratory procedures (line-operated vacuum pump, autoclave, and incubator) or by use of the Millipore portable water laboratory (Anon. 1973, 1975). The water sample is pulled by vacuum through a 47 mm diameter bacterial retentative membrane filter which then is placed in a growth media and incubated at a temperature of 35 C (+ or - 0.5 C) for a period of 22 to 24 hours. Upon removal from the incubator the culture is immediately examined under a low power binocular microscope with fluorescent light or by a hand lens (in the field). Total coliform bacteria colonies are differentiated from other bacteria by distinctive color and sheen characteristics. Results are summarized in tables 12 and 13.

Washington water quality standards (WAC 178-201-030 to 178-201-140) specify that total coliform organisms for natural untreated stream waters shall not exceed median values of 50 to meet Class AA (Extraordinary) classification. Also no more than ten percent of the samples may exceed 230 when associated with a known fecal source. To meet requirements for the Lake Class, the waters of Lake Chelan shall not exceed median values of 240 with less than 20 percent of samples exceeding 1,000 when associated with any known fecal source. Based upon these standards the waters of Lake Chelan and tributary streams in 1975 easily met water quality standards for Class AA and Lake Class. These limited data suggest that sanitary water quality around the head of Lake Chelan is generally excellent, and that fecal contamination from pleasure boats or septic drainfield leaching is not occurring to a detectable degree.

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Table 1. Water temperatures (°C) to 90 meter depths at five mid-lake stations at the head of Lake Chelan on 17 June 1975 between 0905 and 1145 hours PDT.

Depth in Meters	Sta. 1	Sta. 2	Sta. 3	Sta. 4	Sta. 5
Surface	8.3	8.5	9.4	9.3	9.5
1.0	7.8	8.0	8.5	9.0	9.3
2.0	6.6	8.0	8.4	8.5	8.8
3.0	5.5	7.9	8.3	8.4	8.6
4.0	5.5[a]	7.8	8.3	8.4	8.5
5.0		7.8	8.1	8.3	8.5
10		7.7	7.9	8.0	8.1
15		7.6	7.8	8.0	8.0
20		7.6	7.7	7.9	8.0
25		7.5	7.6	7.8	7.9
30		7.5	7.5	7.7	7.9
35		7.5	7.5	7.6	7.8
40		7.4	7.4	7.4	7.7
45		7.4	7.4	7.3	7.4
50		7.3	7.2	7.2	7.3
55		7.3	7.1	7.2	7.2
60		7.0	7.0	7.0	7.1
65		6.9	7.0	7.0	7.0
70		6.7	6.9	6.9	6.9
75		6.6	6.8	6.7	6.8
80		6.6	6.7	6.6	6.8
85		6.5	6.4	6.5	6.7
90		6.5	6.3	6.4	6.7
Mean[b]	6.68	7.35	7.45	7.56	7.66

[a] bottom at 3.75 meters

[b] mean of 9 measurements at station 1 and 116 temperature readings at each of stations 2, 3, 4 and 5

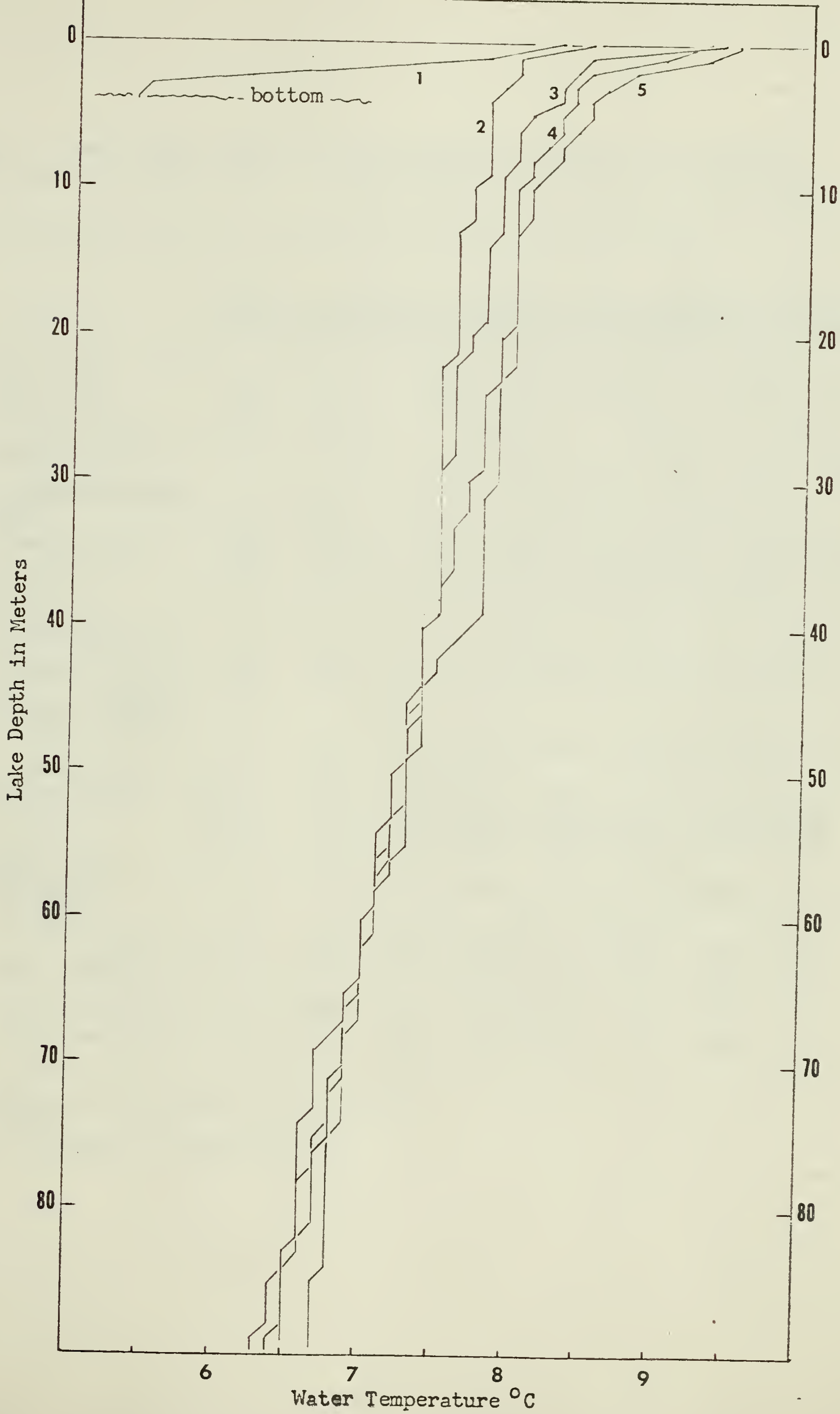

Fig. 1. Thermal profiles at five lake stations on 18 June 1975.

Table 2. Basic water quality at five mid-lake stations at the head of Lake Chelan on 17 June 1975. Surface samples taken at 0.25 meter depth.

	No. 1	No. 2		No. 3		No. 4		No. 5
	Surface	Surface	50 m	Surface	50 m	Surface	50 m	Surface
1. Time (PDT)	0850	0940	1430	1010	1515	1045	1600	1125
2. Air Temp.(°C)	12.3	14.0	-	13.0	-	14.0	-	16.2
3. Water Temp.(°C)	8.1	8.4	7.3	8.7	7.2	9.0	7.2	9.3
4. Dissolved oxygen:								
mg/l	12.0	11.8	11.4	12.2	11.8	11.8	12.0	11.4
% saturation	105	104	98	108	101	106	105	103
5. pH units	7.0	7.10	7.15	7.10	7.20	7.20	7.30	7.20
6. Secchi disc visibility (m)	3.2	9.0	-	9.5	-	9.9	-	13.0
7. Turbidity (JTU)*	1.60	0.44	0.51	0.37	0.47	0.30	0.37	0.28
8. Specific conductance (Mhos/cm)	36.0	45.0	47.5	44.0	42.0	45.9	47.5	45.6
9. Hardness:*								
Ca + Mg (mg/l)	18.34	22.85	21.24	18.91	19.79	18.56	18.89	20.38
Ca (mg/l)	12.22	15.22	17.65	15.30	15.36	16.54	17.07	19.60
10. Alkalinity:								
HCO_3 (mg/l)	15.5	18.75	18.50	18.0	17.0	18.75	18.0	18.5
CO_3 (mg/l)	0	0	0	0	0	0	0	0
11. T.D.I.S.[a](mg/l)*	11.97	17.11	18.81	18.81	17.11	18.81	19.34	18.81
12. Total iron(mg/l)*	0.06	0.025	0.04	0.015	0.05	0.06	0.07	0.07
13. Ferrous iron(mg/l)*	0.02	0.010	0.01	0.005	0.015	0.02	0.025	0.02
14. Ferric iron(mg/l)*	0.04	0.015	0.03	0.010	0.035	0.04	0.045	0.05

*-determined in laboratory on 6/21-24/75

a-total dissolved ionizable solids

Table 3. Levels of several forms of nitrogen in surface waters at five mid-lake stations at the head of Lake Chelan on 17 June 1975.

	Station 1	Station 2	Station 3	Station 4	Station 5
1. Ammonia nitrogen N(mg/l)	0.30	0.35	0.32	0.30	0.30
2. Ammonia NH_3 (mg/l)	0.36	0.43	0.39	0.36	0.36
3. Ammonium NH_4+ (mg/l)	0.39	0.45	0.41	0.39	0.39
4. Total nitrate (NO_3^-) + nitrite (NO_2^-) (mg/l)	0.176	0.176	0.172	0.176	0.176
5. Nitrate NO_3^- (mg/l)	0.170	0.167	0.158	0.172	0.169
6. Nitrite NO_2^- (mg/l)	0.005	0.007	0.010	0.003	0.005

NH_3 = Ammonia N x 1.216

NH_4^+= Ammonia N x 1.288

Table 4. Total zooplankton biomass collected by horizontal and vertical tows with Birge closing net (80 micron mesh size) at two stations at head of Lake Chelan on 19 June 1975 between 0932 and 1118 hours.

	Plankton Biomass (grams)		Water Volume Sampled
	Station 2	Station 4	
5 minute surface (horiz.)	0.26[a]	0.18	b
30 to 20 m (vertical)	0.04	0.04	0.1267 m^3
20 to 10 m (vertical)	0.05	0.03	0.1267 m^3
10 m to surface (vertical)	0.04	0.04	0.1267 m^3
30 m to surface (No. 1)	0.06	0.08	0.380 m^3
30 m to surface (No. 2)	0.07	0.09	0.380 m^3
30 m to surface (mean N=2)	0.065	0.085	0.760 m^3
All 10 m vertical tows (mean N=3)	0.0433	0.0367	0.380 m^3

a considerable amount of surface debris (floating organic matter) in area.

b tow at 500 engine rpm for 5 minute period.

Table 5. Zooplankton biomass per unit volume of water (g/m^3) collected in vertical plankton net hauls at stations 2 and 4, head of Lake Chelan on 19 June 1975.

Station Number and Plankton Net Haul	Zooplankton Biomass (grams)	Water Volume (m3)	Zooplankton Biomass (g/m^3)
Station 2:			
30 m to 20 m	0.04	0.1267	0.3157
20 m to 10 m	0.05	0.1267	0.3946
10 m to surface	0.04	0.1267	0.3157
30 m to surface (1)	0.06	0.380	0.1579
30 m to surface (2)	0.07	0.380	0.1842
Total (all hauls)	0.26	1.140	-
Mean (all hauls)	-	-	0.2281
Station 4:			
30 m to 20 m	0.04	0.1267	0.3157
20 m to 10 m	0.03	0.1267	0.2368
10 m to surface	0.04	0.1267	0.3157
30 m to surface (1)	0.08	0.380	0.2105
30 m to surface (2)	0.09	0.380	0.2368
Total (all hauls)	0.28	1.140	-
Mean (all hauls)	-	-	0.2456
Mean (all 10 hauls)	-	-	0.2368

Table 6. Fish captured in gill nets during faunal studies at the head of Lake Chelan on 16-19 June 1975.

Common Name	Scientific Name	Fish Captured Number	Fish Captured Percent
Rainbow trout	Salmo gairdneri	1	2.8
Burbot	Lota lota	2	5.6
Peamouth	Mylocheilus caurinus	5	13.9
Northern squawfish	Ptychocheilus oregonensis	15	41.7
Largescale sucker	Catostomus macrocheilus	6	16.7
Longnose sucker	Catostomus catostomus	7	19.4
	TOTAL	36	

Table 7. Summary of lengths and weights of 36 fish captured by gill net from the head of Lake Chelan on 16-18 June 1975.

Species	N	Fork Length (millimeters)			Total Length (millimeters)			Weight (grams)		
		Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Salmo gairdneri	1	-	-	157	-	-	167	-	-	45
Lota lota [a]	2	-	-	-	454	349	401.5	565	264	414.5
Mylocheilus caurinus	5	230	173	191.8	254	197	215.6	159	57	82.2
Ptychocheilus oregonensis	15	521	213	280.5	573	240	309.9	2,090	105	342.0
Catostomus macrocheilus	6	355	197	298.3	385	215	323.2	534	100	344.8
Catostomus catostomus	7	401	177	312.1	431	191	332.9	725	65	433.9

a - no fork length category for burbot

Table 8. Condition factors for six species of fish captured by gill net at the head of Lake Chelan between 16-19 June 1975.

		Condition Factor (K-FL)			Mean Condition Factor	
Species	N	Max.	Min.	Range	K-FL	C-FL
Salmo gairdneri	1	-	-	-	1.163	41.98
Lota lota[a]	2	0.621	0.604	0.017	0.612	22.11
Mylocheilus caurinus	5	1.307	0.963	0.344	1.093	39.47
Ptychocheilus oregonensis	15	1.478	1.043	0.435	1.140	41.16
Catostomus macrocheilus	6	1.344	1.110	0.234	1.221	44.07
Catostomus catostomus	7	1.316	1.037	0.279	1.156	41.74

a - total length used in determining condition factor (K-TL and C-TL).

Table 9. Summary of fish capture efforts by use of overnight gill net sets at the head of Lake Chelan between June 1972 and June 1975.

	1972	1973	1974	1975	Four Year Period
Dates	6/17-19	6/27-29	6/26-28	6/16-18	
No. net sets	5	6	4	6	21
Total net area (m^2)	334.4	379.0	267.6	326.1	1,307.1
Total hours worked by combined nets	82.5	89.7	70.4	127	369.6
No. sport fish captured	5	5	6	3	19
No. non-sport fish captured	70	77	58	33	238
Total fish captured	75	82	64	36	257
Mean capture rate:					
No. fish/100 m^2 net/hour of net set	0.272	0.241	0.340	0.087	0.213
No. fish/hour of net set	0.909	0.914	0.909	0.283	0.695

Table 10. Fish species captured in gill nets at head of Lake Chelan in June of 1972, 1973, 1974, and 1975.

Species	1972	1973	1974	1975	4 Year Total No.	4 Year Total Percent
Salmo gairdneri	1	4	1	1	7	2.72
Oncorhynchus nerka	3	0	4	0	7	2.72
Lota lota	1	1	1	2	5	1.95
Mylocheilus caurinus	4	9	6	5	24	9.34
Ptychocheilus oregonensis	34	26	11	15	86	33.46
Catostomus macrocheilus	23	14	23	6	66	25.68
Catostomus catostomus	9	28	18	7	62	24.12
TOTAL	75	82	64	36	247	99.99

Table 11. Basic physical and chemical properties of some streams of the Stehekin River - Lake Chelan drainage in May and November 1975.

				Dissolved O_2							Hardness[d]		Dissolved Iron[e]			
Date	Time	Elev.[a]	°C	mg/l	% Sat.	JTU	pH	HCO_3[b]	Mhos/cm	TDIS[c]	Ca+Mg	Ca	Fe^{+2}	Fe^{+3}	Total	Cl[e]
Agnes Creek																
05/14	1937	474	4.9	13.2	108	1.10	7.00	16.0	37.5	15.4	14.44	11.77	10	20	30	160
Boulder Creek																
05/15	0840	355	5.3	13.6	112	0.36	7.05	11.0	24.0	7.7	11.08	7.77	25	45	70	150
11/06	0910	354	4.6	11.6	94	0.36	7.10	17.5	43.7	16.4	19.99	14.48	30	50	80	-
Bridge Creek																
07/28	1450	1415	12.6	9.8	109	0.58	7.10	11.0	24.3	8.6	11.34	10.20	10	50	60	-
Canyon Creek																
11/04	1440	335	6.3	12.2	102	0.45	6.85	11.0	26.7	8.6	10.40	9.38	25	65	90	-
Castle Creek																
11/04	1600	351	7.6	12.4	107	0.38	7.00	14.5	38.3	15.4	16.12	12.44	25	50	75	-
Company Creek																
05/15	1030	364	5.2	13.4	109	1.25	7.10	20.5	48.3	19.7	17.83	16.34	20	15	35	77
11/06	1550	364	3.8	13.4	105	0.23	6.95	18.0	58.0	22.2	22.64	20.60	20	60	80	-
Coon Lake Run																
05/14	2030	445	10.1	10.6	98	0.46	7.10	24.0	49.3	20.5	22.19	16.77	20	50	70	8

Table 11 (Cont'd.)

				Dissolved O_2							Hardness[d]		Dissolved Iron[e]			
Date	Time	Elev.[a]	°C	mg/l	% Sat.	JTU	pH	HCO_3[b]	Mhos/cm	TDIS[c]	Ca+Mg	Ca	Fe^{+2}	Fe^{+3}	Total	Cl[e]
Flick Creek																
11/05	1120	335	6.9	11.4	96	0.38	7.50	46.0	103.0	41.0	44.27	32.84	25	55	80	-
Fourmile Creek																
11/05	1230	337	6.8	12.0	101	0.16	7.40	32.5	68.0	27.4	30.60	24.28	25	45	70	-
Hazard Creek																
05/16	0850	363	6.4	12.8	107	0.83	7.40	27.0	55.3	22.2	23.11	21.10	10	25	35	120
11/05	1415	337	8.6	10.8	96	0.26	7.60	43.0	87.0	35.9	41.82	33.05	25	55	80	-
North Fork Bridge Creek																
07/29	1900	778	5.6	10.0	88	1.60	6.75	9.0	19.2	5.6	9.77	7.75	6	39	45	-
Purple Creek																
05/13	1945	387	6.5	12.8	108	0.26	7.05	14.0	28.2	8.6	11.52	9.71	10	60	70	5
11/08	0950	387	6.7	11.8	100	0.40	7.25	21.5	47.0	18.8	20.40	16.12	20	60	80	-
Rainbow Creek																
05/15	0940	369	5.2	13.0	107	0.35	6.85	9.0	18.3	6.0	5.71	4.57	20	10	30	100
11/05	1610	369	3.4	12.6	99	0.36	6.85	9.0	24.0	8.0	10.20	7.14	25	40	65	-
Riddle Creek																
11/04	1230	335	5.8	12.4	106	0.20	7.20	19.5	46.0	17.1	18.77	16.32	20	50	70	-

Table 11. (Cont'd)

				Dissolved O_2							Hardness[d]		Dissolved Iron[e]			
Date	Time	Elev.[a]	°C	mg/l	% Sat.	JTU	pH	HCO_3[b]	Mhos/cm	TDIS[c]	Ca+Mg	Ca	Fe^{+2}	Fe^{+3}	Total	Cl[e]
Stehekin River																
05/15	1115	364	5.6	12.8	105	1.10	7.10	17.0	39.8	16.3	16.44	14.40	15	55	70	150
11/07	0940	365	3.7	12.4	98	0.69	7.10	17.5	44.0	17.1	19.99	16.52	30	50	80	-
Unnamed Stream[f]																
05/16	0950	337	6.8	12.6	107	0.03	7.05	11.0	23.1	7.7	9.38	7.33	10	10	20	125

a - elevation in meters
b - bicarbonate alkalinity in mg/l (no CO_3 alkalinity)
c - Total dissolved ionizable solids in mg/l
d - expressed as mg/l $CaCO_3$
e - expressed as μg/l
f - at Purple Point just north of Purple Creek

Table 12. Discharge, velocity, depths and widths of four of the larger streams draining into the head of Lake Chelan in early November 1975.

	Canyon Creek	Castle Creek	Riddle Creek	Company[c] Creek
1. Date	11/04	11/04	11/04	11/07
2. Time (PST)	1440	1600	1230	1000
3. Elevation:				
meters	335	351	335	363
feet	1099	1152	1099	1190
4. Channel Width[a]:				
meters	3.0	3.75	5.2	20.75
feet	9.84	12.30	17.06	68.1
5. Mean Depth[a]:				
meters	0.14	0.16	0.26	0.27
feet	0.45	0.53	0.74	0.89
6. Maximum Depth[a]:				
meters	0.31	0.46	0.41	0.45
feet	1.02	1.51	1.34	1.48
7. Mean Velocity[b]:				
meters/sec	0.81	1.19	1.35	0.475
feet/sec	2.66	3.92	4.44	1.558
8. Mean Discharge:				
m^3/sec	0.34	0.72	1.59	2.66
ft^3/sec (c.f.s.)	11.92	25.48	56.00	94.12

a - at sampling station
b - average of 5 trials in center of channel
c - stream divided into 2 channels

Table 13. Total coliform bacteria tests of water from Purple Creek, unnamed stream just north of Purple Creek, Company Creek and Stehekin Landing well in 1975.

Date	Time	Station No.	Location	Mean No. Coliforms per 100 ml
5/14	2014	60	Purple Creek just below falls	0.0
5/14	2056	61	Purple Creek near lakeshore	0.0
5/15	1055	70	Company Creek near Stehekin River	0.71
5/15	1245	65	unnamed creek at Purple Point	0.0
5/16	1145	61	Purple Creek near lakeshore	2.35
6/20	0630	60	Purple Creek just below falls	12.33
6/20	0638	61	Purple Creek near lakeshore	21.56
6/20	0629	--	Stehekin Landing well	0.0
11/8	1010	60	Purple Creek just below falls*	0.44

* There was no surface flow of Purple Creek near the lakeshore on this date.

Table 14. Total coliform bacteria tests of waters at the head of Lake Chelan in 1975. Taken from 0.25 meter depth between 2014 and 2052 PDT on 5/13; 0630 and 0707 PDT on 6/21; and between 0900 and 1120 PST on 11/8.

Station No.	Location	Date	Mean Number Coliforms/100 ml
63	Off public boat dock at Stehekin	May 13	0.24
64	Off dock of North Cascades Lodge	May 13	0.47
62	Off NPS boat dock at Stehekin	May 16	0.0
63	Off public boat dock at Stehekin	May 16	0.24
64	Off dock of North Cascades Lodge	May 16	2.35
62	Off NPS boat dock at Stehekin	June 20	0.44
63	Off Public boat dock at Stehekin	June 20	0.89
64	Off dock of North Cascades Lodge	June 20	0.44
66	Off dock at Weaver Point	June 20	4.0
67	Open lake about 200 m off Painted Rocks	June 20	1.11
--	Old public boat dock N. of Purple Point	June 20	0.89
--	Little Boulder Cr. inflow to lake	Nov. 8	3.78
--	Gov't. Whaler dock near Purple Cr.	Nov. 8	0.0
62	Off NPS boat dock at Stehekin	Nov. 8	0.0
63	Off public boat dock at Stehekin	Nov. 8	0.44
--	Boat launch ramp south of Purple Creek	Nov. 8	010